What Happens After a Patient Safety Event? Medical Expenditures and Outcomes in Medicare

William E. Encinosa, Fred J. Hellinger

Abstract

Objective: To estimate the impact of potentially preventable adverse events on health care costs and outcomes. **Methods:** We used inpatient, outpatient, and drug claims data for elderly Medicare enrollees with secondary employer coverage from 41 large firms located throughout the Nation in 1999 and 2000. These enrollees underwent 22,477 major surgeries in 1,725 hospitals. The Patient Safety Indicators (2003) of the Agency for Healthcare Research and Quality (AHRQ) were used to identify 14 types of potentially preventable adverse events among the major surgeries. We then conducted multivariate regression analyses—controlling for market characteristics, hospital characteristics, and the patient's risk of adverse outcomes—to predict the expenditures attributable to the potentially preventable adverse medical event, and to predict the probability of death, readmission, and long-term care use after such an event. **Results:** The average difference in total 90-day expenditures between those who had a potentially preventable adverse medical event and those who did not was $35,617. We estimate that 20 percent ($6,998) of this difference was attributable to the actual adverse event. Patients who experienced a potentially preventable adverse medical event had 52 percent higher inpatient hospital expenditures ($P < 0.001$), 21 percent higher inpatient physician expenditures ($P < 0.001$), and 11 percent higher outpatient expenditures ($P < 0.05$) attributable to the event. Medicare paid 86.8 percent of the 90-day costs for patients with patient safety events, compared to 82.9 percent for those without events. The employer paid 11.4 percent of the total 90-day costs for those with patient safety events, compared to 15.0 percent for those without events. Thus, we see that Medicare paid a greater proportion of the extra costs due to the patient safety event. Patients who experienced potentially preventable adverse medical events were 64 percent more likely to use long-term care ($P < 0.001$) and were 2.8 times more likely to die within 90 days than those without events ($P < 0.001$). The death rate attributable to potentially preventable adverse medical events was 4.5 percent. Patients who did not die were 30 percent more likely to be readmitted ($P < 0.05$) within 90 days if they had a potentially preventable adverse medical event. **Conclusions:** Extrapolating our findings to the Nation, we calculate that the 14 potentially preventable adverse medical events identified using AHRQ's Patient Safety Indicator methodology were responsible for 1.1 percent of readmissions, 9.4 percent of deaths, and 1.6 percent ($224 million) of the total 90-day expenditures for all elderly Medicare major surgery patients with secondary employer coverage in 2000.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2005	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
What Happens After a Patient Safety Event? Medical Expenditures and Outcomes in Medicare	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Agency for Healthcare Research and Quality 540 Gaither Road, Suite 2000 Rockville, MD 20850**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**14**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Introduction

Overview

The Committee on the Quality of Health Care in America was established in 1998 by the Institute of Medicine (IOM), and its first report estimated that between 44,000 and 98,000 Americans die each year as a result of medical mistakes.[1] This report attracted considerable attention and increased efforts to improve the safety of health care in this country.

One drawback of the IOM report is that its conclusions regarding the cost of medical errors were not based on a national sample, but were extrapolated from relatively small samples. Another drawback is that the studies upon which its cost estimates are based did not have access to actual insurance claims data for patients who experienced a medical error. This has made it virtually impossible for large health insurers like Medicare to estimate the financial burden they bear due to patient safety problems.

Using a national sample from 1999–2000 (the period the IOM report was released), we examine potentially preventable adverse medical events that occurred over 22,477 Medicare major surgeries across 1,725 hospitals. The sample is large enough that we can estimate precisely the risk-adjusted probability of death and the probability of readmission within 90 days after the potentially preventable adverse medical event. To estimate medical expenditures for the 90 days following the medical injury, we track all of the patient's medical claims for hospital care, inpatient physician care, outpatient care, drugs, and long-term care.

This paper is organized as follows: We introduce the employer claims data and discuss our use of the Patient Safety Indicators developed by the Agency of Healthcare Research and Quality (AHRQ); we then present the results; and we conclude with a discussion of the benefits and cost-savings of reducing medical errors.

Background

Several studies have estimated the cost of injuries related to medical interventions.[2–4] All of these studies rely on professional judgment to identify preventable adverse medical events and to estimate the cost of this event by summing the cost of a hospital day, an outpatient visit, and a physician office visit attributed to the event. Yet, because of the time and cost involved in reviewing medical records, studies based on the review of hospital medical records involve a relatively small number of cases.

In particular, Johnson and colleagues[2] estimated the cost of medical injuries from the New York Medical Malpractice study, which is based on interviews with 794 individuals who had suffered medical adverse events in 1984; Thomas and colleagues[3] estimated the cost of medical errors that occurred in 459 cases in Utah and Colorado hospitals in 1992; and Bates and colleagues[4] estimated the cost of

adverse drug events using 247 adverse drug events in 207 hospitalized patients in 2 hospitals in Boston over a 7-month time period in 1993.

However, two other studies[5, 6] have used large administrative databases to analyze patient safety events. The study by Kalish and colleagues used algorithms to screen 372,680 California hospital discharge abstracts in an effort to identify cases where a medical intervention had resulted in an unintended consequence and where this consequence was determined to have been potentially preventable. Zhan and Miller used the AHRQ Patient Safety Indicators to identify patient safety events among 7.45 million discharge abstracts nationwide. Both of these studies used hospital charge data to estimate the cost of the unintended consequence. However, these studies omitted the cost of services that were not billed by the hospital (e.g., physician services for anesthesia and surgery, and charges for laboratory and imaging services provided by outside facilities) and omitted all subsequent outpatient costs and drug costs.

Methods

Our primary source of data was the 2000 MarketScan Medicare Supplement and Coordination of Benefits Database. This database was created by the Medstat Group, Inc., and contains claims data for inpatient care, outpatient care, and prescription drugs for employees, dependants, and retirees over age 65 years in employer-sponsored retiree benefit plans for 41 large employers in all 50 States. The data includes all employer and Medicare coordination of benefits for these enrollees with both employer coverage and Medicare coverage.

We included all medical claims incurred within 90 days after the surgery admission date. We chose a 90-day period since Brennan et al. reported that 50 percent to 70 percent of patients with adverse events recovered within 90 days.[7] The unit of observation was any major surgery admission (identified as the "index" surgery) that occurred between July 1, 1999, and October 1, 2000, that did not follow another major surgery admission within the previous 90 days for that patient.

We had a total of 22,477 observations. The surgeries occurred at 1,725 hospitals nationwide. Hospital characteristics were obtained from the American Hospital Association's Annual Survey 1999–2000. County characteristics were obtained from the Area Resource File (Bureau of Health Professions, Health Resources and Services Administration).

Potentially preventable adverse medical events

Using Patient Safety Indicators (PSIs) developed by AHRQ, we estimated the cost of potentially preventable adverse medical events for patients who have undergone a major surgical procedure. The PSI methodology identifies as potentially preventable adverse medical events only cases in which the evidence that such an event occurred is preponderant. The PSI methodology has recently been well received in the literature.[6, 8]

We examined 14 potentially preventable adverse medical events defined by the PSI methodology that can occur during major surgery. These 14 adverse events are anesthesia complications, accidental puncture or laceration during the procedure, foreign body left in during the procedure, post-operative hemorrhage or hematoma, wound dehiscence, infection due to medical care, post-operative pulmonary embolism or deep vein thrombosis, iatrogenic pneumothorax, post-operative acute respiratory failure, post-operative sepsis, post-operative physiologic and metabolic derangements, transfusion reaction, post-operative hip fracture, and post-operative decubitus ulcer.

The algorithms used in the PSI methodology identify patient safety problems in administrative discharge data. (You can see the PSI module at the AHRQ Quality Indicator Web site, http://www.qualityindicators.ahrq.gov.) The algorithms flag potentially preventable adverse medical events based on the International Classification of Disease, Clinical Modification, (ICD-9-CM) codes. We have modified the algorithms to also handle procedure codes that are in the Current Procedural Terminology (CPT-4) format.

The PSI algorithms were developed by the University of California, San Francisco–Stanford Evidence-Based Practice Center (EPC), with collaboration from the University of California at Davis, under funding from AHRQ. The PSIs were carefully designed and reviewed by 11 clinical panels to flag potentially preventable adverse events. This process reduced a list of 200-plus possible indicators down to 14 that were likely preventable. Even so, with administrative data it is still impossible to actually know if the event was preventable. However, any adverse event that was not preventable was likely due to a very severe chronic condition of the patient. Thus, we control for 30 comorbidity conditions of the patient, emergency admission, race, sex, etc. In this sense, we do control for adverse events that are nonpreventable due to comorbidities.

In particular, the EPC found that 5 of the 14 indicators could clearly be "labeled" as medical errors: anesthesia complications, foreign body left in during the procedure, iatrogenic pneumothorax, post-operative hip fracture, and post-operative decubitus ulcer. The full EPC Report[9] on how these PSIs were selected, as well as the definition of major surgery, can be viewed at http://www.qualityindicators.ahrq.gov. More information on the PSIs can be found in Romano et al.[10] and Zhan and Miller.[6]

Statistical methods

Our main patient safety variable was modeled as a binary variable that codes a major surgery hospitalization as "1" if at least 1 of the 14 patient safety events occurred during that hospitalization, and codes the surgery hospitalization as "0" if none of the 14 patient safety events occurred. With this model, we then examined (1) expenditures, and (2) patient outcomes associated with potentially preventable adverse medical events. While there may be variation in expenditures and outcomes between each of the 14 PSIs, we did not have a large enough sample to examine each indicator individually. Thus, we pooled all 14 indicators

and looked at their average expenditures and outcomes compared to surgeries without any patient safety event.

Expenditures

Linear regression analysis at the discharge level was used to examine the relationship between the occurrence of a potentially preventable adverse medical event during a surgery and the natural logarithm of the total medical claims cost of treating that patient for 90 days after the admission. The natural logarithm of the expenditures was used instead of the absolute level of expenditures because the distribution of the absolute level of expenditures was skewed. We ran five separate regressions, one on each category of costs: (1) total 90-day expenditures, (2) 90-day inpatient hospital expenditures, (3) 90-day inpatient physician expenditures, (4) 90-day outpatient expenditures, and (5) 90-day drug expenditures. Patients who die in the hospital have high inpatient expenditures but no outpatient or drug expenditures. Since the death rate is much higher for patients experiencing potentially preventable adverse medical events, we chose to conduct the 90-day outpatient and drug regressions with the sample restricted to those who did not die during the 90 days.

Since we wanted to estimate the portion of the 90-day expenditures that were due to the potentially preventable adverse medical event and not due to patient, hospital, health plan, or market characteristics, we included the covariates from Table 1 in each of the five expenditure regressions. We included the following to control for potential confounding effects of patient severity: age, age squared, gender, an indicator for emergency room admission, and indicators for 30 chronic conditions developed by Elixhauser et al.[11] and updated by the Stanford EPC in the AHRQ PSI software.[9]

Next, to control for demand-side factors that may influence the patient's degree of use, we controlled for the type of the health plan, union status, and the median household income for the patient's county. Since we pooled data from 2 years, we also included indicators for each year to control for any time trend.

To control for market characteristics, we included the 1998 county health maintenance organization (HMO) penetration rate. Hospital characteristics include teaching hospitals, rural hospitals, hospital ownership, and hospital bed size. The hospital bed size (small, medium, large) is defined in the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample documentation (see http://www.hcup-us.ahrq.gov).

Finally, not shown in Table 1, we controlled for the type of surgery by including indicator variables for 221 Diagnosis-Related Groups (DRGs). Since the five expenditure regressions used the log of expenditures, we did not report the estimated coefficients. Instead, we used the regression results to simulate the non-logged expenditures that were due to potentially preventable adverse medical events. Since the disturbances were heteroscedastic, we chose to use the log-link Generalized Linear Method (GLM) of regression with a gamma distribution

family in Stata 7.0. In all our GLM regressions, the robust standard errors were estimated using the Huber/White sandwich estimator.

Next, we used a simulation method that is similar to that found in Escarce et al.[12] Using each of the five GLM expenditure regressions, we first assumed everyone in the sample had a potentially preventable adverse medical event and predicted their expenditures. We then assumed no one in the sample had a potentially preventable adverse medical event and predicted their expenditures. The difference in the predictions would be the predicted expenditures due to patient safety events. The standard errors of the predicted difference in expenditures due to a potentially preventable adverse medical event were computed using the Delta Method.[12, 13]

Finally, since long-term care was rarely used by patients in the sample, we predicted long-term care use in two stages: first, the probability of the use of long-term care following a potentially preventable adverse medical event using a logistic regression; second, using a log-link gamma GLM regression on those patients with positive long-term care expenditures during the 90 days to predict long-term care expenditures due to potentially preventable adverse medical events.

Outcomes

Using a logistic multivariate regression at the discharge level, we estimated the probability of dying within 90 days after a surgery in which a potentially preventable adverse medical event occurred. Similarly, we estimated the probability of being readmitted within 90 days after a hospitalization in which a potentially preventable adverse medical event occurred. While the first (index) admission had to be a major surgery, the readmission did not have to be a surgery. Finally, using logistic analysis, we estimated the probability of using long-term care within 90 days after a hospitalization in which a potentially preventable adverse medical event occurred. In all logistic regressions, the robust standard errors were estimated using the Huber/White sandwich estimator and were corrected for clustering at the hospital.

All three outcome logistic regressions used the same covariates found in Table 1, and also controlled for 23 Major Diagnostic Categories (MDCs). All three outcome logistic regressions were then used to predict the probability of each of the three outcomes under a patient safety event. The predicted probabilities of each outcome are reported in Table 4.

Results

During the study period, 4.02 percent of the 22,477 senior citizen major surgeries had at least one of the 14 potentially preventable adverse medical events (PSIs). In Table 2, we compare the costs of surgeries with patient safety events to those without patient safety events, controlling for the patient, hospital, and market covariates of Table 1, and controlling for DRGs. We see the patients with

Table 1. Sample means of covariants for patient safety events [a]

Variables	PSI	No PSI
Emergency admission	0.051	0.082
Female	0.499	0.539
Age	74.819	76.266
Union	0.253	0.286
Fee-for-service plan	0.748	0.726
Preferred provider organization	0.231	0.250
Point-of-service plan	0.006	0.006
Capitated plan	0.015	0.018
Area characteristics (county)		
HMO penetration	0.247	0.273
Media income	$37,609	$38,683
Hospital characteristics		
Small bedsize hospital	0.076	0.088
Medium bedsize hospital	0.249	0.249
Large bedsize hospital	0.675	0.663
Teaching hospital	0.508	0.512
Public hospital	0.079	0.062
Not-for-profit hospital	0.857	0.895
For-profit hospital	0.064	0.043
Urban hospital	0.868	0.911
Patient chronic conditions		
Congestive heart failure	0.038	0.171
Arrhythmias	0.077	0.217
Valvular disease	0.027	0.091
Pulmonary circulation disease	0.003	0.008
Peripheral vascular disease	0.026	0.062
Hypertension	0.151	0.179
Paralysis	0.005	0.016
Other neurological disorders	0.019	0.061
Chronic pulmonary disease	0.064	0.132
Diabetes	0.052	0.076
Diabetes with chronic complication	0.009	0.133

Table 1. Sample means of covariants for patient safety events [a], cont.

Variables	PSI	No PSI
Hypothyroidism	0.012	0.013
Renal failure	0.020	0.057
Liver disease	0.003	0.003
Peptic ulcer disease x bleeding	0.003	0.008
Aids	0.001	0.001
Lymphoma	0.004	0.007
Metastatic cancer	0.019	0.026
Solid tumor w/out metastasis	0.068	0.085
Rheumatoid arthritis coolagen vas	0.007	0.007
Coagulopathy	0.007	0.020
Obesity	0.001	0.001
Chronic blood loss anemia	0.004	0.009
Deficiency anemias	0.023	0.043
Alcohol abuse	0.002	0.001
Drug abuse	0.001	0.001
Psychoses	0.004	0.012
Depression	0.002	0.006
Sample size	21,574	903

[a]PSI refers to a patient safety event occurring.

adverse events had 90-day costs that were 40 percent higher—$24,317 compared to $17,319 for those without adverse events. Medicare paid 86.8 percent of these costs for patients with patient safety events ($21,110), compared to 82.9 percent for those without events ($14,350). The employer paid 11.4 percent of the total 90-day costs for those with patient safety events ($2,775), compared to 15 percent for those without events ($2,598). Thus, we see that Medicare paid a greater proportion of the extra costs for a patient safety event.

Table 2. The financial burden of a patient safety event, adjusted for covariates [a]

	Observations	Total Payment
No PSI	21,574	$17,319
PSI	903 *(PSI Rate: 4.02%)*	$24,317

[a]These are payments for medical care in the 90 days following a hospital admission in 1999 and 2000 for Medicare enrollees with secondary employer coverage, adjusting for the covariates in Table 1 and for DRGs. PSI refers to a patient safety event occurring.

Next, Table 3 breaks down the total costs of Table 2 into various categories of expenditures. Table 3 predicts the expenditures attributable to the potentially preventable adverse medical event by controlling for the covariates of Table 1, as well as controlling for the type of surgery by DRG. Total 90-day expenditures are 40.4 percent higher for surgical patients who experienced a potentially preventable adverse medical event. The total payments predicted to be due to the potentially preventable adverse medical event are $6,998 ($P < 0.001$). Also, 90-day inpatient physician payments are predicted to be 20.6 percent higher under a potentially preventable adverse medical event, with $360 actually predicted to be due to the potentially preventable adverse medical event ($P < 0.001$). Similarly, 90-day outpatient expenditures (for those who did not die) are predicted to be 10.5 percent higher under an event, with $288 in extra outpatient payments attributable to the event ($P < 0.05$). There is no statistically significant difference in outpatient drug use for those patients with patient safety events.

Table 3. Predicted medical expenditure for patient safety events, adjusted for covariates [a]

	Inpatient Hospital Payments	Inpatient Physician Payments	Outpatient Payments	Drug Payments	Total Payments	Portion Due To Long Term Care
PSI	$19,455	$2,104	$2,746	$551	$24,317	$631
No PSI	$12,775	$1,744	$2,458	$570	$17,319	$486
Payment Difference	$6,680** (1,367)	$360** (119)	$288* (134)	-$19 (24)	$6,998** (1,269)	$145** (68)
Percentage Difference	52.3%	20.6%	10.5%	-3.3%	40.4%	29.8%

[a]These are predicted payments for medical care in the 90 days following a major surgery admission in 1999 and 2000 for Medicare enrollees with secondary employer coverage, adjusting for the covariates in Table 1 and for DRGs. PSI refers to a patient safety event occurring. Outpatient and drug payment means are conditional upon not dying. However, total payment is not conditional upon not dying, so the sum of the subpayments across each row is greater than the total payment in the final column. Standard errors are in parentheses.
**Significantly different from zero at the 99% level.
*Significantly different from zero at the 95% level.

Without controlling for covariates, the 90-day costs for patients with adverse events are $35,618. Comparing this to our risk-adjusted result in Table 3, where total payments are $24,317 after controlling for covariates, we can see that about 68 percent ($24,317) of the $35,618 is most likely preventable.

The readmission and death rates of Table 4 are risk-adjusted, controlling for the covariates of Table 1 and for DRGs. In the readmission column of Table 4, we exclude those who died during the first hospitalization. We can see that those who survived and had a patient safety problem had a 29.63 percent higher probability of being readmitted than those who did not have a potentially preventable adverse medical event ($P < 0.02$). The predicted readmission rate is 10.85 percent for surgeries with potentially preventable adverse medical events and 8.37 percent for those without potentially preventable adverse medical events.

Table 4. Predicted outcomes for following a patient safety event, adjusted for covariates [a]

	90 Day Death Rate	Readmission Rate for Survivors	Long Term Care Use
PSI	6.15%	10.85%	9.21%
No PSI	1.62%	8.37%	5.61%
Difference	4.53%**	2.48%*	3.60%**
	(1.41)	(1.11)	(1.10)
Percentage Difference	279.63%	29.63%	64.17%

[a]These are predicted outcomes in the 90 days following the admission date of a major surgery in 1999 and 2000 for Medicare enrollees with secondary employer coverage, adjusting for the covariates in Table 1 and for MDCs. PSI refers to a patient safety event occurring. Standard errors are in parentheses.
**Significantly different from zero at the 99% level.
*Significantly different from zero at the 95% level.

In the death column of Table 4, we see that surgeries with potentially preventable adverse medical events had a probability of death within 90 days more than three times as high as those without a patient safety problem ($P < 0.001$). The predicted 90-day death rate for surgeries with potentially preventable adverse medical events is 6.15 percent, compared to 1.62 percent for those without safety events. Taking the difference of the two death rates, we see that potentially preventable adverse medical events were responsible for a death rate of 4.53 percent.

In the last column of Table 4, we see that surgeries with potentially preventable adverse medical events were 64.17 percent more likely to need long-term care afterward. Long-term care includes inpatient and outpatient claims from facilities such as skilled nursing facilities, intermediate care facilities, geriatric hospitals, convalescent care facilities, and extended care facilities. (The total payments in Tables 2 and 3 include long-term care payments.) Long-term care does not include home health care. In Table 4, the predicted probabilities for using long-term care are 9.21 percent for those with potentially preventable adverse medical events, and 5.61 percent for those without potentially preventable adverse medical events. Thus, in Table 3, any patient with an adverse event is expected to have $631 in expenditures on long-term care during the 90 days, as opposed to $486 for those patients without adverse events. Moreover, only 2.1 percent (145/16,998) of the predicted 90-day expenditures due to potentially preventable adverse medical events are attributable to long-term care in Table 3.

The 5 medical errors in the 14 PSIs make up 13 percent of the adverse event cases we examined in this paper. Controlling for comorbidities, we find that the total 90-day costs (per patient) of these 5 medical errors is $21,478, compared to $12,775 (in Table 3) for those patients without any of the 14 adverse events. Similarly, patients with these 5 medical errors are 2.5 times more likely to die or are 2.4 times more likely to be readmitted, compared to patients without any of these 14 adverse events.

Discussion

The results on the costs of medical errors presented in the Institute of Medicine's report, *To Err Is Human*, were based on the small sample, State studies of New York[2, 7, 14] and Colorado-Utah.[3, 15, 16] These samples were too small to derive cost estimates of patient safety for Medicare patients. To address this problem, in this paper we examined a national sample of elderly Medicare patients with secondary employer coverage.

First, our results provide insight into the composition of medical expenditures 90 days after a potentially preventable adverse medical event. The bulk of the extra expenditures over the 90 days, due to potentially preventable adverse medical events, are inpatient hospital payments. About 5 percent of the 90-day expenditures due to adverse events are physician inpatient payments. On average, about 4 percent of the 90-day expenditures due to adverse events are outpatient payments. Even though all the enrollees had drug coverage from the employer, patient safety events did not result in any extra outpatient drug payments.

This is in contrast to the Utah-Colorado study, where malpractice claims adjustors proposed that 46 percent of the extra lifetime medical costs due to patient safety problems would be outpatient costs.[3] This large outpatient composition of expenditures in the Utah-Colorado study is due to the fact that their malpractice claims adjustors attributed 37 percent of the lifetime expenditures on patient safety care to nursing home care. In contrast, we find that only 2.1 percent of the 90-days expenditures due to potentially preventable adverse medical events are attributable to long-term care.

Next, our results provide insight into the magnitude of the 90-day medical expenditures attributable to potentially preventable adverse medical events. We find that patient safety events are responsible for $6,998 in 90-day medical expenditures spent by patients experiencing adverse events. The strength of our study is that we used actual insurance claims (transacted payments) to calculate the costs of a potentially preventable adverse medical event. No other expenditure study uses payments. For example, the studies by Kalish et al.[5] and Zhan and Miller[6] use hospital charges instead of payment claims, overestimating what was actually paid. Kalish et al. found that major surgeries with complications (a broader category than patient safety event) in 1988 had inpatient charges of $16,023 ($22,188 in 2000 dollars) attributable to the complication.

A second study, the Harvard Medical Practice Study, interviewed 794 patients in 51 hospitals in New York who had been injured during hospitalization in 1984 to ascertain their outpatient medical care use between the hospitalization in 1984 and July 1988.[2] They roughly estimated that the lifetime medical costs for these injuries (attributable to injuries and not the illness) were $18,305 per person injured in 1989 dollars ($23,367 in 2000 dollars). However, in that study, much of the costs were based on what the patient or family recalled 5 years after the potentially preventable adverse medical event, with the authors assigning prices to the recalled utilization.

A third study by Thomas et al.[3] examined only 265 preventable hospital adverse events that occurred in 1992 in 28 hospitals in Utah and Colorado. They then had 10 malpractice insurance claims adjusters provide an expert opinion on what the lifetime costs of these injuries would be. They found that the lifetime medical costs for these injuries were $17,976 per person injured in 1996 dollars ($20,036 in 2000 dollars). However, in that study, costs were based on claims adjustors' expert opinion of what utilization probably would have occurred, given the medical chart of the medical injury.

Our study overcomes these limitations by using actual insurance payments for major surgeries in a large national sample of 1,725 hospitals. Our results can be extrapolated to get a national estimate of the 90-day medical expenditures outcomes due to potentially preventable adverse medical events in 2000 for Medicare patients with secondary employer-sponsored health insurance. First, using the HCUPnet National Inpatient Sample (HCUPnet) and Medicare statistics, we estimate that there were 795,006 major surgeries in the United States in 2000 for elderly Medicare patients with secondary employer-sponsored coverage. Since our estimated rate of potentially preventable adverse medical events is 0.0402 for major surgeries, using Table 2 we estimate that total 90-day expenditures for all 795,006 major surgeries in the United States for elderly Medicare patients with secondary employer coverage in 2000 were $14.0 billion. Of that, (795,006)(0.0402)(6,998) = $224 million is predicted to be due to the potentially preventable adverse medical events. That is, the expenditures due to these 14 patient safety events were 1.6 percent of all 90-day medical expenditures following all major surgeries for all U.S. Medicare patients with employer coverage in 2000. In comparison, the Colorado-Utah study found that preventable adverse events were responsible for lifetime health care costs that made up 1.1 percent of total health care expenditures in Colorado and Utah in 1996.[3]

Next, using the death rates predicted from Table 4, 0.0615 for potentially preventable adverse medical events and 0.0162 otherwise, we can calculate that for the 795,006 Medicare major surgeries in year 2000, 1,445 of the deaths among patients with potentially preventable adverse medical events were actually due to the safety event. Thus, 9.4 percent of the 15,302 major surgery deaths in 2000 were due to potentially preventable adverse medical events for major surgery elderly Medicare patients with employer coverage.

Similarly, using the readmission rates predicted from Table 4, we can calculate that for the Medicare major surgeries in 2000 without immediate death, 726 of the readmissions for surgeries with potentially preventable adverse medical events were actually due to the safety event. Thus, 1.1 percent of all the 67,488 readmissions in 2000 were due to potentially preventable adverse medical events for major surgery elderly Medicare patients with employer coverage.

Recall that these potentially preventable adverse medical events are based only on 14 measurable PSIs. Thus, there may have been many more preventable safety events (as well as close calls) that occurred but that were not included in our analyses, such as medication errors. In fact, we did not consider drug-related errors, diagnostic errors, and errors in choice of therapy, all of which accounted

for 12 percent of surgical errors in the Colorado-Utah study.[16] Thus, our expenditure results are an underestimate of all the expenditures attributable to all preventable adverse events.

Nevertheless, these 14 potentially preventable adverse medical events were deemed to be highly preventable by 11 clinical panels, and yet they resulted in excess deaths, readmissions, and expenses for elderly surgery patients with both Medicare and employer coverage. Moreover, our employer data comes from some of the Fortune 500 corporations. Of all Medicare patients in the country, these would be the ones suspected of having top-notch health insurance coverage, with the best choice of doctors and hospitals. Yet, among surgeries alone, these 14 potentially preventable adverse medical events caused 1.1 percent of their readmissions, 9.4 percent of their deaths, and 1.6 percent of their 90-days medical expenditures.

Acknowledgments

This research was funded by the Agency for Healthcare Research and Quality. The views herein do not necessarily reflect the views or policies of AHRQ, nor the U.S. Department of Health and Human Services. We thank our programmers Linda Andrews of Social and Scientific Systems, Inc., and Yafu Zhao of Coda Research, Inc.

Author affiliation

Both authors are affiliated with the Agency for Healthcare Research and Quality, Center for Delivery, Organization and Markets.

Address correspondence to: William E. Encinosa, Ph.D.; Center for Delivery, Organization and Markets; AHRQ; 540 Gaither Road; Rockville, MD 20850; phone: 301-427-1437; fax 301-427-1430; e-mail wencinos@ahrq.gov.

References

1. Kohn LT, Corrigan JM, Donaldson MS, editors. To err is human: building a safer health system. A report of the Committee on Quality of Health Care in America, Institute of Medicine. Washington, DC: National Academy Press; 2000.
2. Johnson WG, Brennan TA, Newhouse JP, et al. The economic consequences of medical injuries: implications for a no-fault insurance plan. JAMA 1992 May 13;267(18):2487–92.
3. Thomas E, Studdert DM, Newhouse JP et al. Costs of medical injuries. Inquiry 1999; 36(3):255–64.
4. Bates DW, Spell N, Cullen DJ, et al. The costs of adverse drug events in hospitalized patients. JAMA 1997;277(4):307–11.
5. Kalish RL, Daley J, Duncan CC, et al. Costs of potential complications of care for major surgery patients. American Journal of Medical Quality, Spring 1995;10(1);48–54.
6. Zhan C, Miller M. Excess length of stay, charges, and mortality attributable to medical injuries during hospitalization. JAMA 2003;290(14):1868–74.
7. Brennan T, Leape L, Laird N, et al. Incidence of adverse events and negligence in hospitalized patients: results from the Harvard Medical Practice Study I. New England Journal of Medicine 1991;321:480–4.
8. Weingart S, Iezzoni L. Looking for medical injuries where the light is bright. JAMA 2003;290(14):1917–19.

9. McDonald K, Romano P, Geppert J, et al. Measures of patient safety based on hospital administrative data—the patient safety indicators. Technical Review 5. AHRQ Publication No. 02-0038. Rockville, MD: Agency for Healthcare Research and Quality; August 2002.

10. Romano PS, Geppert JJ, Davies S, et al. A national profile of patient safety in U.S. hospitals. Health Aff 2003 Mar–Apr; 22(2):154–66.

11. Elixhauser A, Steiner C, Harris D, et al. Comorbidity measures for use with administrative data. Med Care 1998 Jan;36(1):8–27.

12. Escarce J, Kapur K, Joyce GF, and Van Vorst KA. Medical care expenditures under gatekeeper and point-of-service arrangements. Health Services Research 2001;36(6):1037–57.

13. Manning W. The logged dependent variable, heteroscedasticity, and the retransformation problem. The Journal of Health Economics 1998;17:283–95.

14. Leape L, et al. The nature of adverse events in hospitalized patients: results from the Harvard Medical Practice Study II. New England Journal of Medicine 1991;324(6):377–84.

15. Thomas EJ, Studdert DM, Burstin HR, et al. Incidence and types of adverse events and negligent care in Utah and Colorado. Med Care 2000 Mar;38(3): 261–71.

16. Gawande AA, Thomas EJ, Zinner, MJ, et al. The incidence and nature of surgical adverse events in Colorado and Utah in 1992. Surgery 1999;126(1): 66–75.